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FORMING PROCESS OF CRYOCONITE GRANULES ON QAANAAQ GLACIER, NORTHWESTERN GREENLAND

Jun Uetake *(Transdisciplinary Research Integration Center, Japan)*
Takahiro Segawa *(Transdisciplinary Research Integration Center, Japan)*
Nozomu Takeuchi *(Chiba University, Japan)*
Naoko Nagatsuka *(National Institute of Polar Research, Japan)*
Hideaki Motoyama *(National Institute of Polar Research, Japan)*
Teruo Aoki *(Meteorological Research Institute, Japan)*

juetake@nipr.ac.jp

The cryoconite is dark-colored sediment on glacier surface, which consists of mineral particles from surrounding and biogenic organic matter produced by microorganisms living on the glacier. The cryoconite absorbs solar radiation and change thermo energy causing excessive melting of the ice around and beneath it.
Wientjes et al., 2010 shows that similar visible dark colored band called “dark region” is found every summer in the same position at some distance from the margin of western Greenland Ice Sheet. This region was covered by ancient dust mainly deposited in Holocene and photosynthesis microorganisms and microbial organic material significantly reduce the albedo and accelerate the melting. However, forming process of cryoconite granules had not been well described before.
In order to understand the reason for cryoconite formation on certain parts of Qaanaaq Glacier, we will focus on the set of analysis of 6 different size (diameter 30-249μm, 100-249μm, 250-499μm, 500-749μm, 750-999μm, more than1000μm) sorted cryoconite granules. We analyzed carbon and nitrate (CN) amount, and bacterial 16S rRNA gene diversity change of size sorted cryoconite granule. We measured carbon (TC), nitrogen (TN) and cryoconite (CR) mass (g/m^2), then after calculate these ratio (%) in cryoconite granules. TC, TN and CR mass (g/m^2) would show distribution pattern of cryoconite granules on Qaanaaq Glacier, and TC and TN ratio (%) would show structural changes from germination stage of cryoconite granules to mature stage.
The average carbon ratio of cryoconite granules ranged from 0.67 to 5.23% and that of nitrogen ranged from 0.08 to 0.47% throughout all study sites. Average TC and TN ratios of Size 30 – 100 ranged from 0.81 to 1.19% and from 0.10 to 0.11% (Supplemental table 1). Otherwise these of Size 250 – 1000 ranged from 2.10 to 4.54% and from 0.12 to 0.44%, respectively.
After clustering and removal of chloroplast gene sequences, bacterial and archaeal 16S sequence count ranged from 42,606 to 142,147. Taxonomical classification (99%) by Qiime using Silva database shows eleven major phyla (more than 0.1 %) are included in cryoconite granules from different sites and size series. Major phyla represent Acidobacteria (1.0-16.7%), Actinobacteria (3.6-22.4%), Armatimonadetes (0.0-6.0%), Bacteroidetes (12.9-68.5%), Chlamydiae (0.0-0.2%), Chloroflexi (0.0-3.2%), Cyanobacteria (0.1-32.3%), Deinococcus-Thermus (0.0-2.0%), Planctomycetes (0.0-0.2%), Proteobacteria (12.3-37.8%), WCHB1-60 (0.0-0.1%). Relatively higher minimum ratio of Bacteroidetes and Proteobacteria may indicate these two are widely distributed through samples in despite of differences of sites and size, otherwise ratio of cyanobacteria show gradient between samples. Although total number of OTU in this study is 100,033, we focused top 42 major OTU, which percentage of sequence count against whole sequences (sequence percentage) are more than 0.2%. Most of relatives are from glacier environment in Svalbard, Arctic sea ice, Alaska and High altitude Chinese mountain glacier.

Reference

Wientjes I.G.M., Oerlemans J. 2010. An explanation for the dark region in the western melt zone of the Greenland ice sheet. Cryosphere, 4, 261–268.